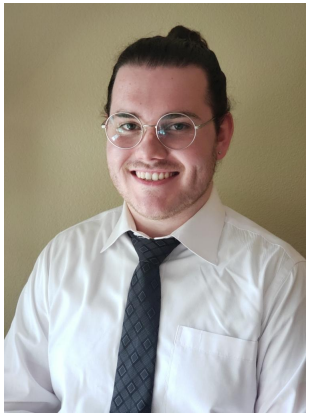
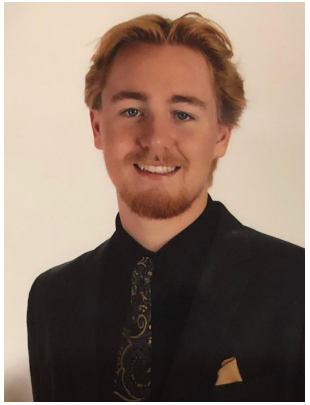
Fire Scout

A Modern Take on Fighting Wildfires

Team Fire Scout

Team Leader	Release Manager	Recorder	Hardware Researcher	Interface Manager
				
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Mentor

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Client

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Problem

Fires

- Unpredictable
  - USA 2019 - **4,664,364 acres**
  - USA 2018 - **8,767,492 acres**
- California 2020
  - 4.2 million acres burnt
  - 33 direct lives lost
  - Indirect deaths of 1,200+
  - $10 Billion total economic loss

Analysis

- Not real-time
- Information gap
- Expensive
- Risk human lives

Solution

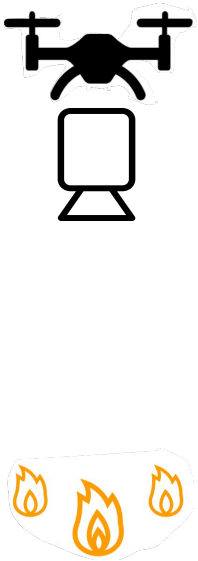
- Unmanned Aerial Vehicles (UAVs)
  - Remove humans from fire
  - Provide real-time data
  - Implement AI

- Onboard Hardware
  - Nvidia Jetson Nano
  - HD and thermal cameras
  - Image processing algorithms
  - SDR communication

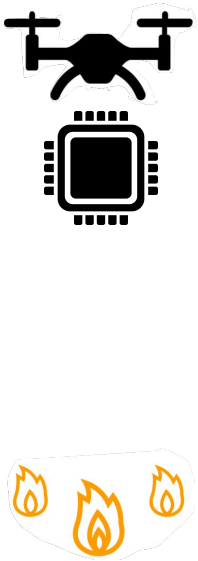
The Process

1. Pilot Flies the Drone

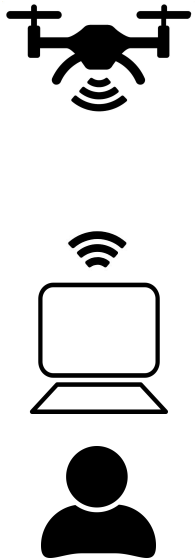
2. Drone Finds Fires



3. Drone Processes Fires



4. Drone Sends Data to User



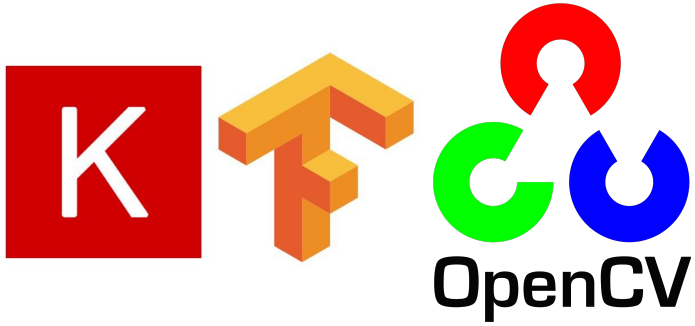
Requirements

- DJI Phantom 3 Pro or DJI Matrice 200
- Nvidia Jetson Nano
  - Image Classification
  - Object Detection
  - Image Segmentation
  - Path Planning
- PiCamera v2
- FLIR Vue Pro R Thermal Camera
- SDRs
- GUI

Architecture

- **Front-end**
  - Python
  - Tkinter

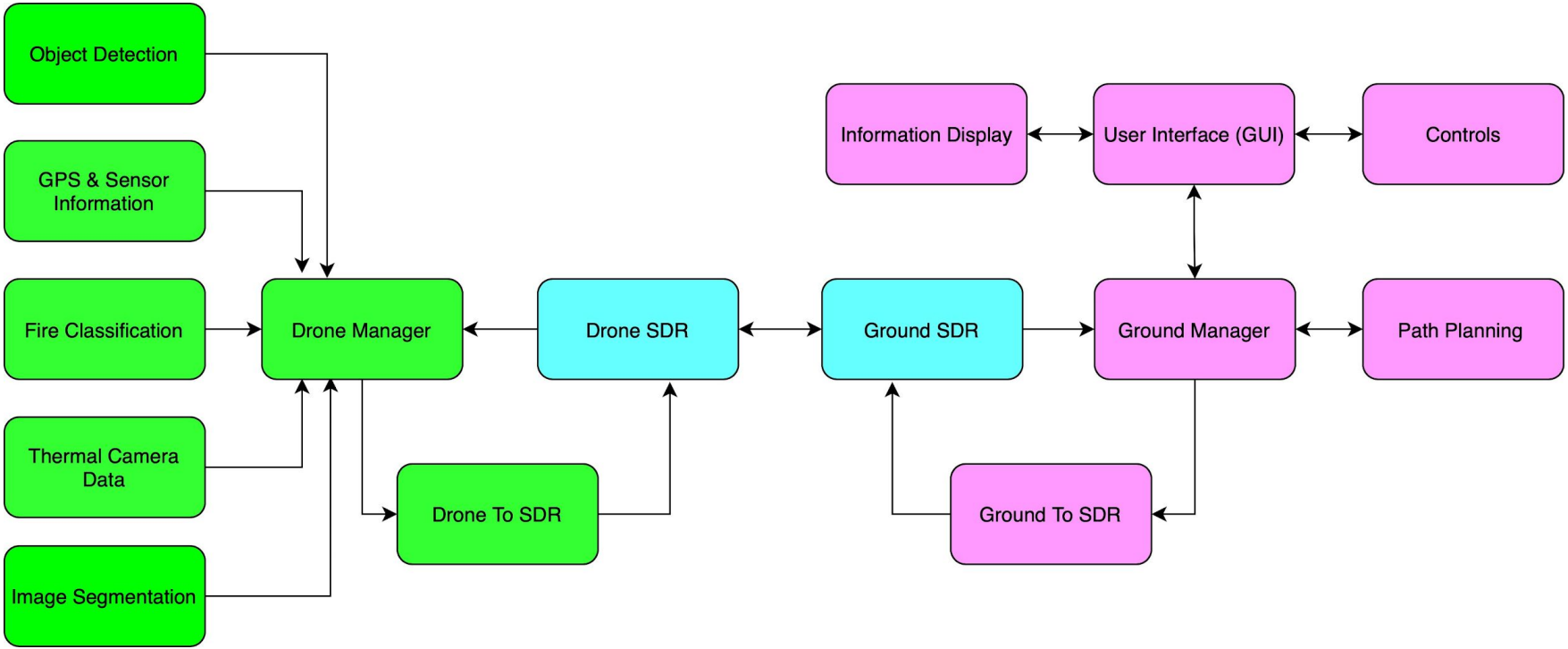
- **Back-end**
  - OpenCV
  - Tensorflow
  - Keras
  - Yolov3
    - Darknet
  - U-Net



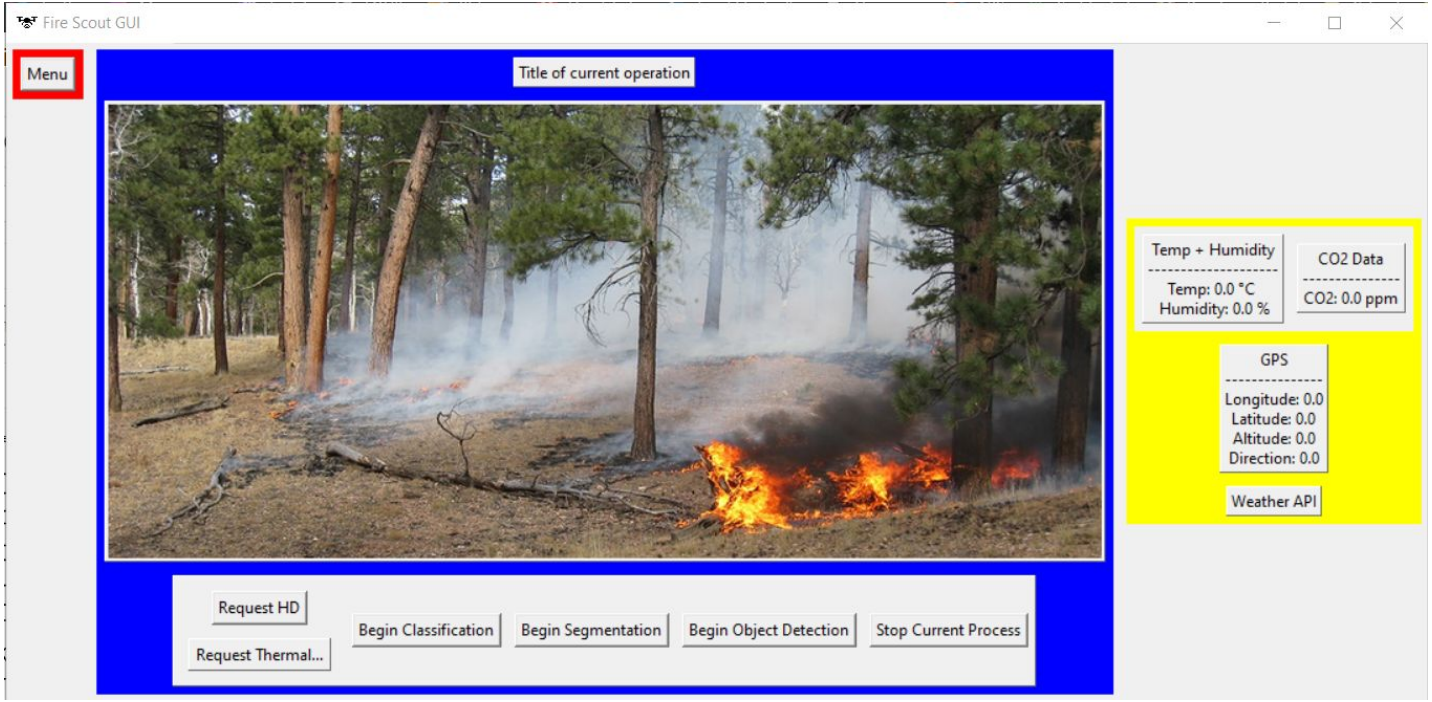
Implementation

- **Drone System**
  - Run AI models
  - Gather info from sensors
  - Pass it to the SDR
- **SDRs**
  - Relay information
- **Ground System**
  - Display info
  - Present user with drone System Controls

Implementation



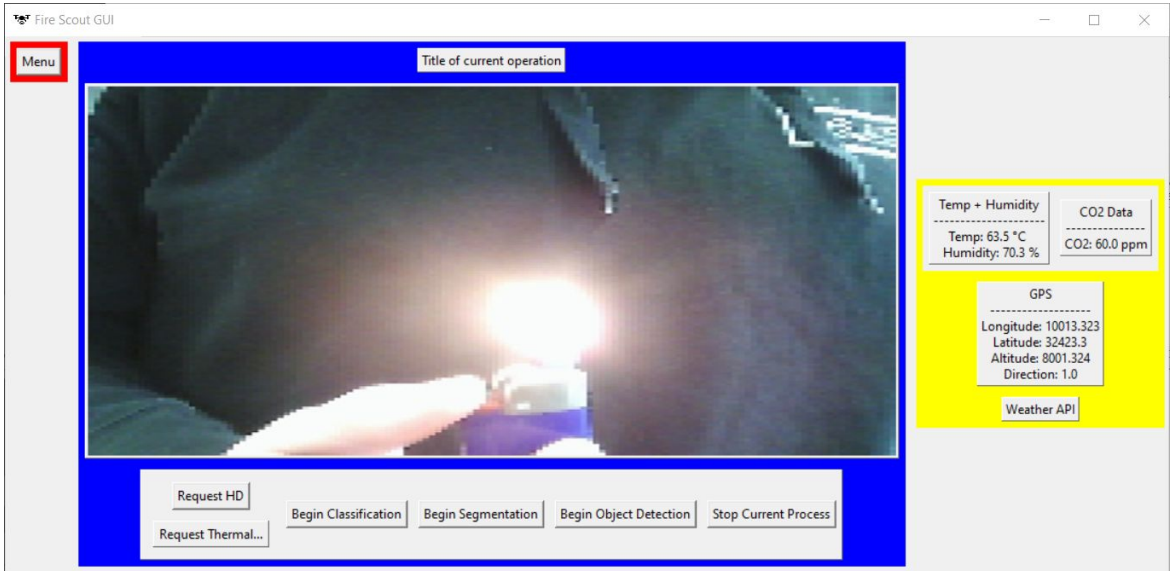
Prototype


Fire Scout GUI
Menu
Title of current operation
Temp + Humidity
Temp: 0.0 °C
Humidity: 0.0 %
CO2 Data
CO2: 0.0 ppm
GPS
Longitude: 0.0
Latitude: 0.0
Altitude: 0.0
Direction: 0.0
Weather API
Request HD
Request Thermal...
Begin Classification
Begin Segmentation
Begin Object Detection
Stop Current Process

Prototype

Drone Sends Sensor Info

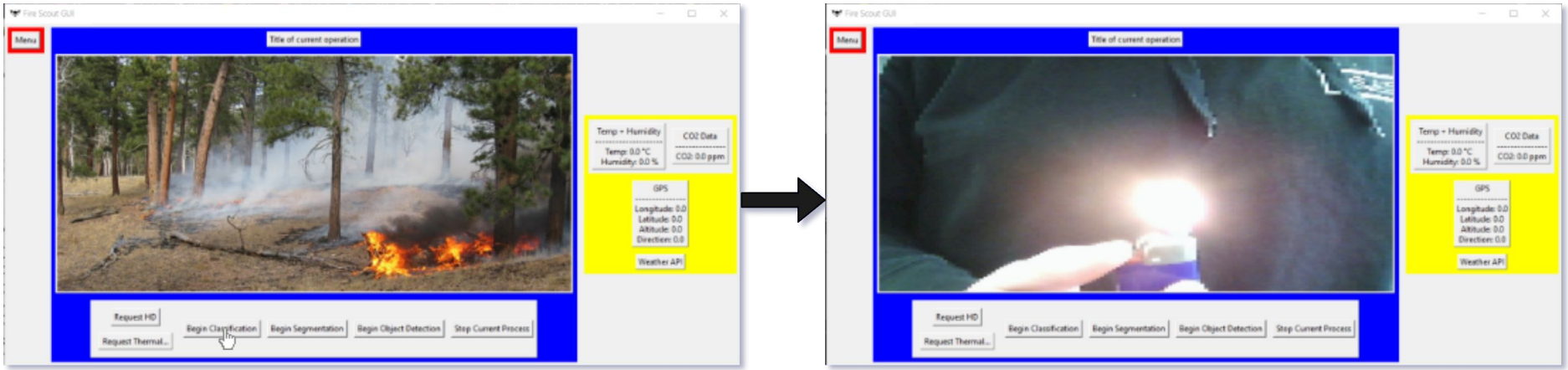
- Sensor Input



Prototype

- Classification
  -Binary fire vs no fire detection

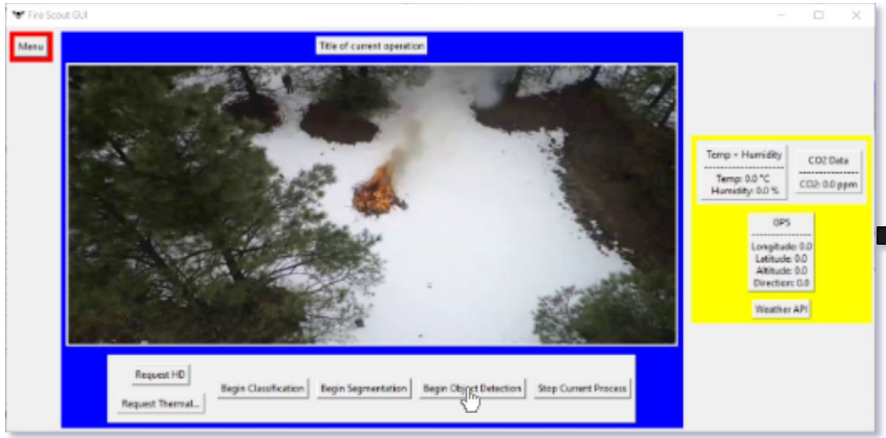
Drone Finds Fires



Prototype

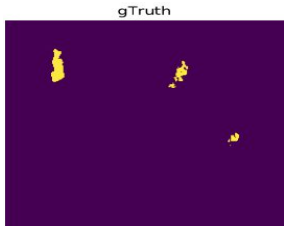
Drone Processes Image

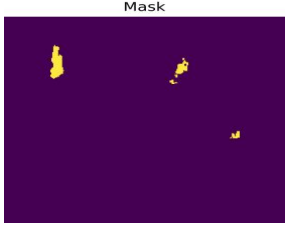
- Object Detection
  - Detection based on patterns



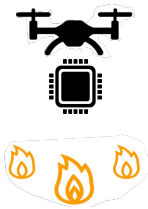
Prototype

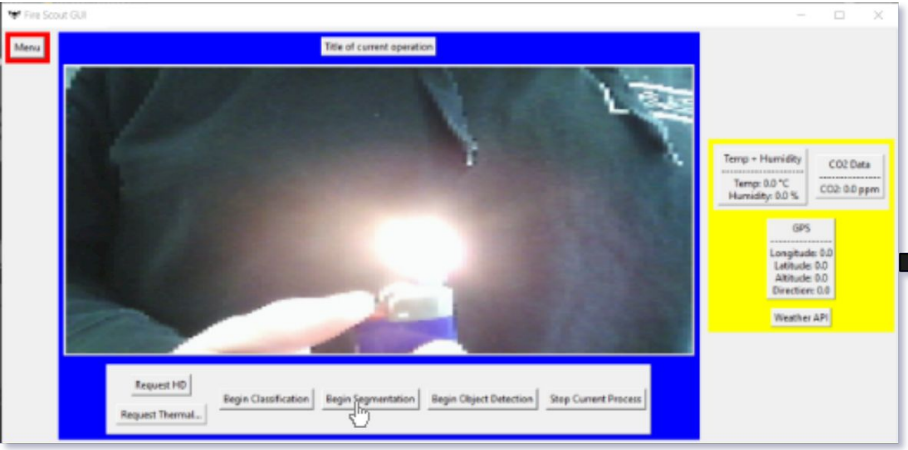
- Segmentation
  -Binary pixel level detection

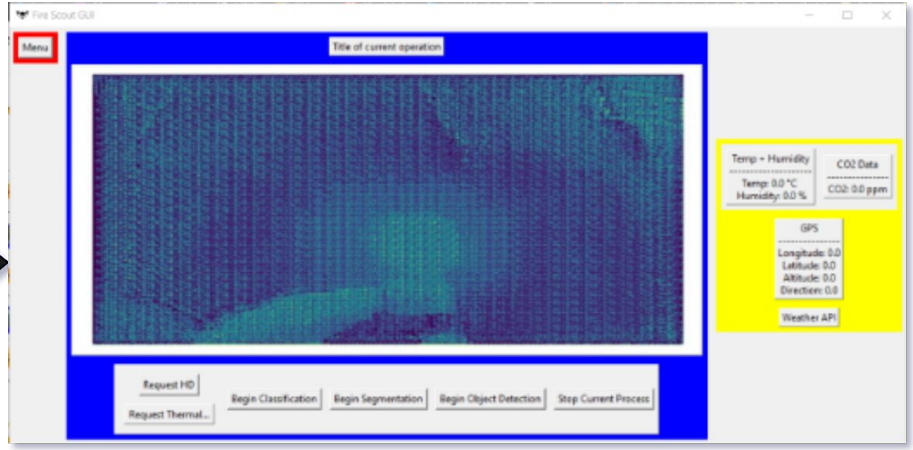




Drone Processes Image



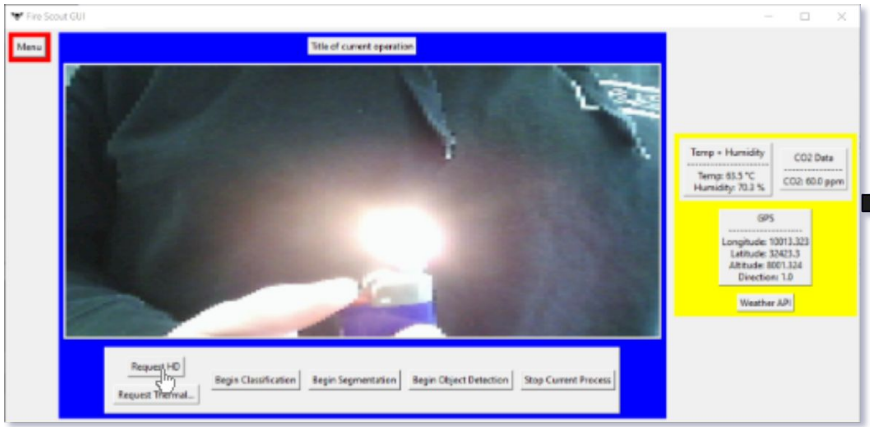


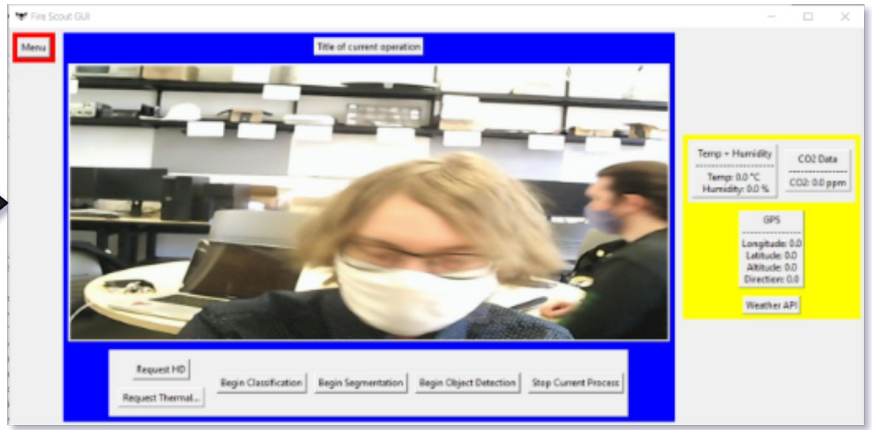


Prototype

- HD Capture

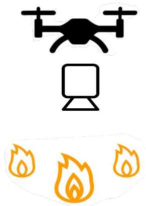
Drone Takes
HD Snapshot



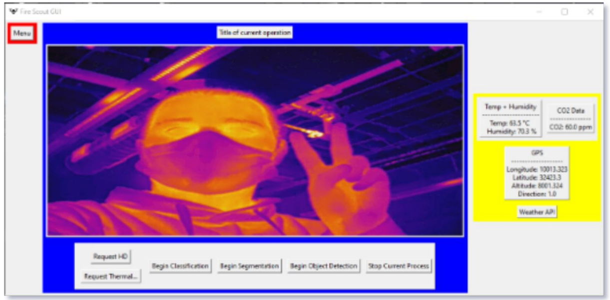


Prototype

Drone Takes Thermal Snapshot

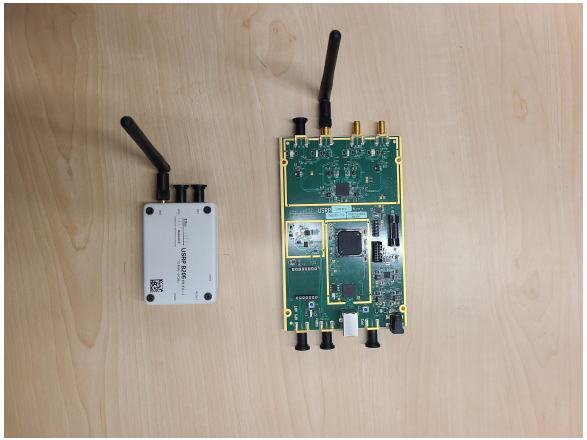


- Thermal



Challenges

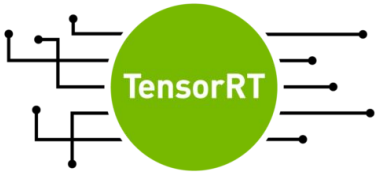
- Nvidia Jetson Nano
  - Converting models to Nvidia Jetson Nano
  - Different versions (Python, Tensorflow)
  - OOM errors
  - Lack of documentation
- SDR pipeline



Drone SDR (left) and Ground Station SDR (right)

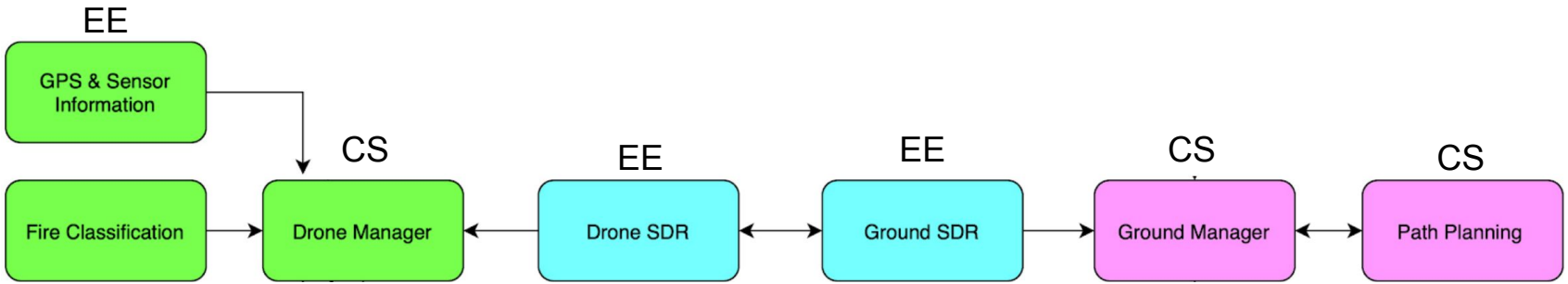
Solutions

- TensorRT
- Custom Models
- Virtual Environments
- Working with EE to get the SDR to an acceptable state

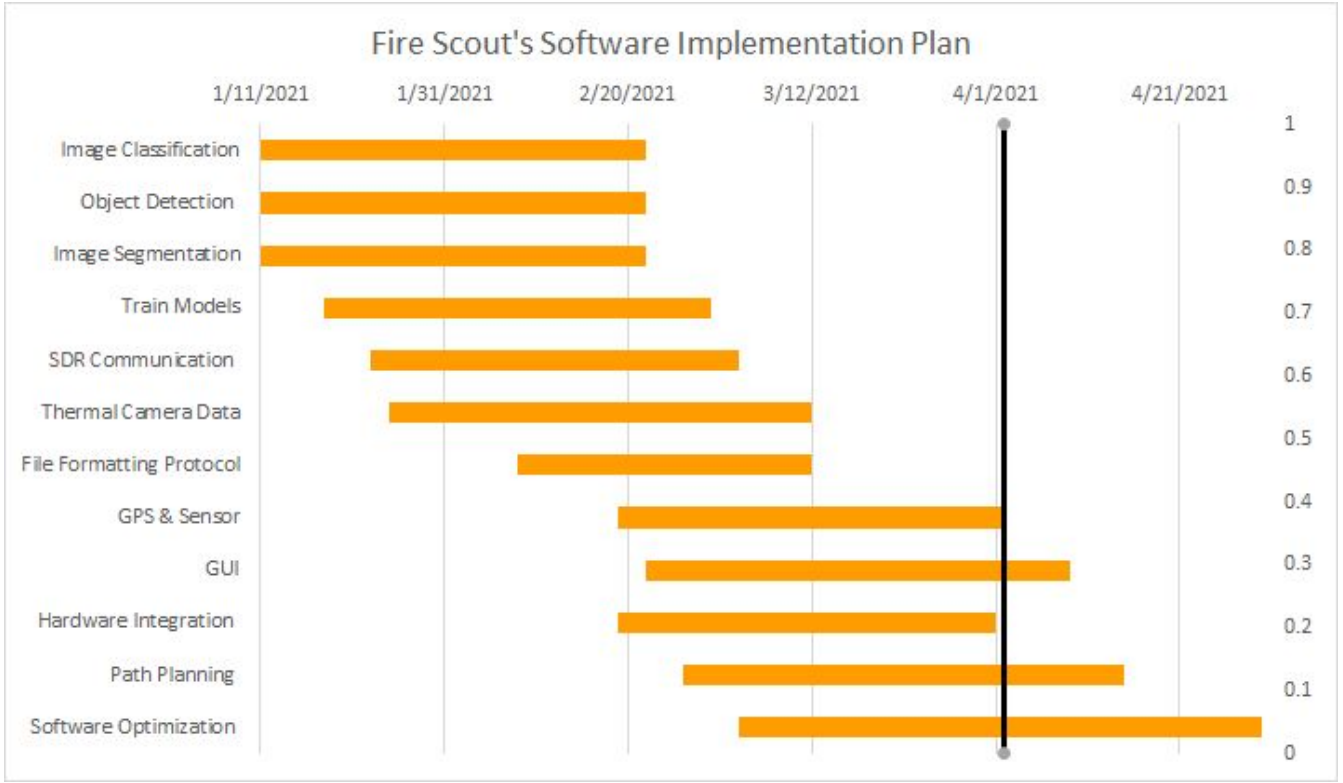


Testing Plan

- Unit Testing the classes sent through the SDR
  - Used by CS and EE
- Integration and System testing
  - CS's modules "integrate" through EE's modules
  - EE Dependent



Schedule


Fire Scout's Software Implementation Plan
1/11/2021
1/31/2021
2/20/2021
3/12/2021
4/1/2021
4/21/2021
Image Classification
Object Detection
Image Segmentation
Train Models
SDR Communication
Thermal Camera Data
File Formatting Protocol
GPS & Sensor
GUI
Hardware Integration
Path Planning
Software Optimization
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

Conclusion

- Fires kill and need to be fought in a unique ways
- Fire Scout saves lives and fights fires in a modern way
  - AI can detect and analyze fires
  - Emphasis on future developers
- Whats next…
  - Finishing EE integration
  - Optimizing models
  - Gathering Metrics

Sources

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